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GENERAL SCIENCE IN IOWA HIGH SCHOOLS

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Courses in general science have been introduced in the last five years in about one hundred accredited Iowa high schools. In over 75 per cent of these schools the subject was introduced for the first time during the current year (1915–16). The status of the course is, therefore, as yet undetermined.

This study covers the status of general science in 247 of the 345 high schools accredited by the higher educational institutions of Iowa.

SOURCE OF DATA

To secure the necessary data a letter and questionnaire were sent early in January, 1916, to the principals of the 345 accredited Iowa high schools. The responses were prompt, and, for the most part, complete. They evidence the wide-spread interest that principals and teachers have in this subject. Of the 345 schools to which the request for information was sent, 247, or 71 per cent, replied. For the convenience of the reader the answers to each question are summarized and discussed in the order in which the questions occurred in the questionnaire.

1. *Is general science taught?*—The replies show that general science is not taught as yet in the majority of the accredited high schools of this state. Of the total number of schools, 100, or 28 per cent, are now offering the subject; about 15 per cent of the schools not offering the subject are thinking of introducing it "next year." In 90 of the 100 schools the course is one semester in length.

2. *When was it introduced?*—For the most part the subject has been introduced within the last year. Only two schools have offered the subject for more than three years. The returns from the 100 schools offering the subject are as follows: 1 school offered it for the first time in 1910–11; 1 school offered it for the first time

in 1911–12; 2 in 1912–13; 6 in 1913–14; 13 in 1914–15, and 77 in 1915–16.

3. *What subjects, if any, were displaced by general science?*—Apparently high-school teachers and principals do not know what to do with regard to science in the high school. A number of them are questioning the value of some of the more traditional sciences, and are willing to sacrifice a half or a whole year of such subjects. They feel that a course in general science is bound to come, and that they had better begin experimenting with it in order to keep abreast with the times. They have devised a variety of ways of relieving the congestion caused by the course, as shown in the following summary. Certain science subjects, such as physical geography, botany, zoölogy, and physiology, are most often displaced. On the other hand, "word analysis" has been displaced in 1 school, mediaeval and modern history in 1, civics in 1, and Latin in 1.

Physical geography displaced in..................	47 schools
Physical geography and botany displaced in.......	8 schools
Physical geography and zoölogy displaced in.......	2 schools
Physical geography and botany and zoölogy displaced in..................................	3 schools
Physical geography and physiology displaced in....	3 schools
Mediaeval and modern history displaced in........	4 schools
Commercial geography displaced in..............	2 schools

The following subjects were displaced once each: geology, in 1 school; word analysis, in 1 school; botany and physiology, in 1 school; biology, in 1 school. Latin was reduced to 3 years in 1 school; civics was reduced to 1 half-year in 1 school, and manual training, domestic science, and agriculture were displaced in 1 school. In 15 schools only was there no displacement of other subjects.

These figures are not in agreement with those given by Mr. A. M. Taylor in a recent article. Mr. Taylor[1] states that, "In a majority of the cases there has been no recognized displacement of other subjects." The figures here reported would indicate that *in a majority of cases there has been a marked displacement of other*

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[1] Taylor, "General Science Situation in Iowa and California," *School Review*, January, 1916.

subjects. This displacement has affected physical geography, botany, and zoölogy rather seriously.

The statements made by the principals of the high schools introducing general science show how serious this displacement is. The following are typical:

1. Our present course in general science is for one semester only. Next year we intend to make it a full-year course and *eliminate botany entirely as a special subject*.

2. We had a full year of civics. We reduced it to one-half in order to introduce general science.

3. We give three years of Latin now instead of four. [Science has taken the place of the fourth year.]

4. We reduced botany to one semester.

5. We eliminated the one-semester course in physiology.

6. No displacement; general science elective. Offered especially to students in the commerical course.

7. We omit physical geography. [One semester of physical geography was eliminated in 42 schools, while in 19 schools the year course was eliminated, general science being substituted.]

8. Botany and zoölogy were removed from the first to the third year of the high-school course.

9. Ancient history was put into the Sophomore year.

4. *What textbook is used?*—The present popularity of textbooks in general science is shown in the following figures which state the number of schools using each. In all, 96 schools reported.

Caldwell and Eikenberry, *General Science*	31
Snyder, *First Year Science*	30
Clark, *General Science*	13
Pease, *First-Year General Science*	9
Hessler, *First Year of Science*	12
Rowell, *Introduction to General Science*	1
Total	96

5. *Comparison of textbooks in general science.*—In order to give a partial answer to the many questions which arise concerning the merits of textbooks in general science, a rough comparison of the six textbooks is made. As may be seen, the method of comparison is very simple. Down the left-hand side of Table I are the names of special sciences which a course in general science might possibly be expected to cover. These sciences are: physics, chemistry, biology (botany and zoölogy and physiology), agriculture (not

included under biology), commercial geography. This comparison was made by Mr. Andrew M. McMahon, a senior student in physics. It is very difficult to distribute some of the material that appears in these textbooks. Mr. McMahon has used his best judgment. At least it is possible to gain from such a comparison a general idea of the textbooks. In certain instances it may be found that these figures are not exact. It is very difficult to be exact in such a comparison. The writer feels that the comparison is fair, and that the facts are sufficiently exact for all ordinary purposes.

TABLE I

Showing the Number of Pages in Six General-Science Textbooks Given to the Different Special Sciences

	Hessler	Clark	Snyder	Caldwell	Pease	Rowell
Physics	150	249	67	76	74	108
Chemistry	88	56	10	12	22	33
Biology (Zoölogy, Botany, Physiology)	178	26	82	131	48	63
Agriculture	10	0	15	15	2	30
Geology	14	0	198	19	83	21
Meteorology	26	0	41	39	12	18
Astronomy	0	0	30	3	31	19
Commercial geography	0	0	0	8	0	0
Illustrations (total number)	311	241	307	137	161	0
Questions	0	0	some	0	some	0
Experiments	200	100	130	50	80	90

Table I should be read as follows: 150 of the pages in Hessler's book on general science are devoted to a discussion of physics, while Clark spends 249 pages on this subject, Synder only 67, Caldwell 76, Pease 74, and Rowell 108.

A careful study of these figures shows that 3 of the 6 textbooks stress physics, 2 biology, and 1 physical geography. It is apparent that writers of general-science textbooks do not agree as to what should constitute a course in the subject. Where the doctors disagree, what can the laymen do?

6. *The amount and character of laboratory work.*—The current practice is shown fully by the following summary of 99 replies:

5 schools have laboratory work amounting to 2 double (forty-minute) periods per week.

21 schools have laboratory work amounting to 2 forty-minute periods per week.

21 schools have laboratory work amounting to 1 period per week.

4 schools devote from 80 to 160 minutes per week to laboratory work.

23 schools report that they have "some," "little," "occasional," laboratory work "as needed." All such work is "class demonstration" to serve as "illustration"; that is, the teachers "show things as they appear in the text."

25 schools either fail to answer or say frankly that they do not have laboratory work in connection with general science.

There appears to be little attempt to teach science by projects or problems. The subject is treated about the same as history or economics. Assignment is made to the text, the assignment is learned by the pupils, and recited next day. The teacher demonstrates ten to twenty-five experiments during the course. A special laboratory for general science cannot be found in Iowa. The present laboratories are inadequately equipped in a majority of the schools.

7. *Amount and character of field work.*—In at least 50 of the 100 schools no field work is required or given. In 20 additional schools a negligible amount of field work is offered. In the remaining schools some field work is given, the amount varying from "one trip in the spring" to "at least two trips each month." One school says: "We have field work whenever needed to make teaching effective." Another says: "We have just enough to illustrate plant life and growth, also to see geological features, erosions, etc." Two or three schools postpone all field work to the spring of the year. One thing stands out prominently in all the replies, namely, field work is not as yet highly regarded in connection with general science.

8. *In what year is the course offered?*—Replies to this question show very clearly that general science at present is a ninth-grade subject in Iowa high schools; in but four schools has any attempt been made to teach the subject in the eighth grade. In but one school is the subject taught in the tenth year. Does not an introductory course of this character belong in the seventh or eighth grades? Perhaps, as Professor Woodhull states, the entire science course of the elementary and high schools should be reorganized with the principle of general science as the controlling consideration.

9. *Are pupils from other years allowed to enter the class?*—The replies indicate that the course is primarily intended for the particu-

lar grade; in about 20 schools no other pupils are permitted; in the remaining schools other pupils may take the course, but they do not usually do so.

10. *Who teaches general science?*—In 56 high schools the course is taught by a man, and in 39 schools by a woman. In a few schools in which more than one division of the course is maintained, certain divisions are taught by a man and others by a woman. Forty-three of the 92 replying are teaching science only. The remaining teachers have combinations, according to the necessities of the high-school program. Such combinations as general science, history and economics, or general science, pedagogy, history, reading, and civics, are hard to justify. Can general or special science be properly presented by teachers so burdened? The certificate to teach in Iowa high schools is a blanket certificate. That is, it permits a teacher to teach anything. From the standpoint of the highest efficiency this is an unfortunate situation, and until it is remedied no great improvement in science-teaching can be expected.

11. *Academic training of general-science teachers.*—If general science is to be taught successfully, it is obvious that exceptionally well-prepared teachers are necessary. The questions arise: Is the subject now being taught by teachers especially prepared in science? How much science training have these teachers had through their collegiate courses? It was to secure data on these problems that question 10 was asked.

Many teachers failed to understand the question or failed to answer it adequately. The data for 48 teachers are chosen as typical of the group. Unfortunately, agriculture was not included in the questionnaire. Therefore it is not possible to state here the preparation these teachers had in that subject.

According to our data, the average teacher of general science devoted, during his collegiate course, the following number of semester hours to the study of each of the sciences named: 1.4 hours to astronomy; 2.12 hours to geology; 13.2 hours to chemistry; 5.4 hours to zoölogy; 5.4 hours to botany; 1.9 hours to physical geography; 9.6 hours to physics; 3.0 hours to physiology and bacteriology; 0 hours to general science.

Teachers are best prepared in chemistry, physics, zoölogy, and botany. They are twice as well prepared in physics and chemistry, as measured by the number of semester hours, as are teachers of zoölogy and botany. They are very poorly prepared in geology, physical geography, physiology, and bacteriology.

It appears that a special course for the preparation of prospective teachers of general science is needed in colleges and universities. Such a course should include approximately eight hours in each of the following sciences: chemistry, physics, zoölogy, botany, and possibly agriculture. The course should also include at least four semester hours of work in geology and physical geography, astronomy, physiology, and bacteriology. In addition, there should be at least a two-hour course in general science, and at least two hours of required observation and practice teaching in the subject of general science. At present science teachers in the high schools of Iowa have had approximately forty hours of work in science during their collegiate course. They have majored in some one department, in which more than half of their work in science was taken. Our present organization is chiefly directed toward making teachers of the special sciences. Reorganization and an increase in the amount of work in science are necessary, if the colleges and universities expect to meet the needs and demands of the high school.

12. *Science courses in the high school.*—The relative frequency of occurrence of different courses in science in the eighth to twelfth grades, inclusive, is shown by the following figures, which include 100 high schools. In 42 schools geography is taught in the eighth grade; physiology in 26; agriculture in 25; and general science in 4. The figures for the other grades are as given below:

Eighth Grade		First Year of High School		Second Year of High School	
Geography	42	General science	77	Botany	20
Physiology	26	Physiology	21	Agriculture	14
Agriculture	25	Physical geography	17	Physiology	12
General science	4	Botany	16	Physical geography	9
Physical geography	2	Agriculture	13	Zoölogy	9
Elementary science	1	Zoölogy	2		

Third Year of High School		Fourth Year of High School	
Agriculture	30	Physics	67
Domestic science	14	Chemistry	10
Physics	13	Agriculture	7
Physiology	9	Physiology	4

The two subjects occurring most frequently are physiology and agriculture. These occur in all grades. Geography and physiology are the dominant science subjects in the eighth grade. General science is the dominate subject in the ninth grade. Physical geography, botany, and physiology were the dominant science subjects in the ninth grade, but they have been displaced in these schools by general science. Such figures show how extremely individualistic Iowa high schools are. Organization and standardization is needed. At present we do not know what to teach.

13. *Reasons for not introducing general science.*—A number of the replies from Iowa high schools not teaching general science state their reasons. A summary of the reasons given includes the following:

1. We have no room in which to teach general science.
2. We are using our physiology as a sort of general-science course.
3. Work of the first year in high school is already too heavy.
4. I think general science covers too much ground and gives too much smattering knowlege, and this becomes unscientific. I have always considered it a smattering of several things and not enough of any one to make a lasting impression.
5. I consider it of little value in the high school as now organized, but worth while in the seventh or eighth grade.

14. *Limitations of general science.*—The limitations of present courses in general science most commonly noted by Iowa teachers and principals are:

1. A vast amount of work is attacked, without being fixed in the mind of the student.
2. At present it is difficult, if not impossible, to know what phases should be most emphasized.
3. The average young teacher does not know science well enough and has not had sufficient experience in the work, to make the course very valuable.
4. Little or no opportunity as yet has been provided for field work, and the laboratory work is very unsatisfactory.
5. "Our worst handicap is to find teachers fitted to teach a subject which covers so many different sciences. Under the average teacher it becomes an elementary course in his specialty. If he is a physicist the course is elementary physics; if, on the other hand, he majored in agriculture or biology the course becomes an elementary course in agriculture or biology. To call it a 'general' science course is to misapply the term."
6. The course cannot be covered in one semester; it should be a full year's work. If made a full year's work it displaces to a considerable extent the

biological and earth sciences in the ninth grade. Several principals do not feel that this is justifiable.

7. The most serious objection is to the character of the textbooks. Almost every respondent mentions this fact. The textbooks are entirely inadequate. One man says: "If the good parts of five or six books that are now on the market in general science could be put together in one text, with some modifications, a suitable text might be provided. At present all the books are 'baby' books."

8. No college-entrance credit for the subject is frequently mentioned as a serious objection.

9. It does not teach the pupils to think in scientific terms.

10. It does not prevent failures in later specialized sciences. Seven teachers say: "We have not been able to trace any effects of the course in the attitude of students toward later science courses." The teachers frankly state that they are not aware, in their physics classes, whether a pupil has had general science or not.

15. *Value of general science.*—The values placed upon general science by high-school principals and teachers are varied. A large majority of those who have introduced it frankly state that it is an experiment, and that they do not know as yet just how valuable the course may prove. Many feel that the course is valuable, but are unable to state why. Other teachers are positive that the course does not measure up to their expectations, while a third group feel that the course is among the most valuable in the high school. Among the values most commonly noted by members of the third group are the following:

1. General science teaches the pupil how to study a science, how to think in scientific terms. Answer: Special courses in science will do this as well.

2. General science prepares for the study of physics and other sciences; it is an interesting and easy approach to special science. Answer: Elementary rather than general science would do this even better.

3. General science develops an inquiring spirit. Answer: All subjects should do this.

4. General science gives a summary of the fundamentals of science; it gives children scientific information which they crave. Answer: Good if true.

5. General science helps bridge the gap between the work in the eighth and the ninth grades. Answer: Not proved.

6. General science prevents many failures in the later specialized sciences. Answer: Not proved.

7. General science gives pupils who do not go on some idea of the field of science. Answer: Yes, valuable for this.

Professor John F. Woodhull of Columbia University, in a brief article which appeared in *School Science and Mathematics*, October, 1914, gave a summary of opinions concerning the value of courses in elementary and general science. The trend of opinions in favor of such courses was as follows:

1. Young people, in the upper grades of the grammar school and in the high school, desire information from the whole field of science. They are in the depths of superstition about common things. The problems of real life are not differentiated, after the manner of specialized science, into astronomy, chemistry, zoölogy, physics, botany, and the like. The greatest need, and likewise the greatest demand, among even the highly educated, is for *information* rather than *training* in science. Attention should be focused on teaching children rather than subjects. All workers and students require training *in their specialty*, but in other fields they want knowledge in simple form and by the most direct method. This makes general science necessary. Instruction in science throughout the elementary school and high school should be general rather than special.

2. The public needs unmistakably require a new organization of science instruction according to *projects*. These projects should be derived largely from experience. There should be books, not one but many, and these should be used quite freely as in history and in English. The teaching in science should be quite as informational as it is in history, English, and other subjects. The study of *projects* in science will necessitate the breaking down of the boundary fences that have been erected between highly specialized sciences. General science should be adapted to local conditions and may not be universalized. Many projects elaborated by ingenious and skilled teachers should be published in a series of small books or pamphlets for the use of pupils. Teachers may select from these as time, place, and circumstances require. Enough of this material may easily be prepared to occupy many years of study on the part of the pupils. What is worth while to know from the fields of astronomy, botany, chemistry, geology, meteorology, physics, physiology, zoölogy, etc., may be thus acquired.